Appendix A. Supporting Figures for Section 3.2.2 (Model Results)

These animations (Figures A-1 through A-9) provide context for the still images shown in Section 3.2.2.

Figure A-1. RAQMS-modeled ozone at the 300 K isentrope-level from May 6 at 12:00 UTC to May 11 at 12:00 UTC. The model was initialized at 12:00 UTC on May 6.

Figure A-2. RAQMS-modeled ozone at the 300 K isentrope-level from May 9 at 12:00 UTC to May 14 at 12:00 UTC. The model was initialized at 12:00 UTC on May 9.

Figure A-3. RAQMS-modeled ozone at the 310 K isentrope-level from May 6 at 12:00 UTC to May 11 at 12:00 UTC. The model was initialized at 12:00 UTC on May 6.

Figure A-4. RAQMS-modeled cross-section of ozone from May 6 at 12:00 UTC to May 11 at 12:00 UTC. The model was initialized at 12:00 UTC on May 6.

Figure A-5. RAQMS-modeled CO at the 310 K isentrope-level from May 6 at 12:00 UTC to May 11 at 12:00 UTC. The model was initialized at 12:00 UTC on May 6.

Figure A-6. RAQMS-modeled cross-section of CO from May 6 at 12:00 UTC to May 11 at 12:00 UTC. The model was initialized at 12:00 UTC on May 6.

Figure A-7. RAQMS-modeled cross-section of CO from May 9 at 12:00 UTC to May 14 at 12:00 UTC. The model was initialized at 12:00 UTC on May 9.

Figure A-8. WACCM-modeled stratospheric ozone from May 7 at 00:00 UTC to May 10 at 00:00 UTC.

Figure A-9. Ozone mass mixing ratio, Instantaneous from the MERRA-2 model on May 7 at 0:00 UTC to May 9 at 23:59 UTC.

Figures A-10 through A-12 depict the stratospheric ozone (O3S) tracer time series and correspond to the WACCM latitudinal cross sections of total ozone concentration in Figure 3-16 and Figures 3-19 through 3-28 in Section 3.2.2. The modeled O3S cross section profiles indicate a persistent feature along the transport path to Clark County. Due to the expected chemical and dry deposition losses of a stratospheric ozone contribution during multi-day transport, the O3S values decrease over time leading up to the event day. This positive detection of stratospheric influence is within the range of SOI episodes detected previously. Chouza et al. 2020 report comparable values for the stratospheric ozone tracer in the WACCM model near Clark County (15-20 ppb in the boundary layer during the May 6 event) with a typical interquartile range including exceptional SOI event days during late spring 2019 and 2020. Furthermore, the total ozone bias in WACCM is typically +20% or less near the surface (Chouza et al., 2020). Overall, the WACCM model results provide evidence for a detectable stratospheric ozone influence on May 9, 2020, in Clark County.

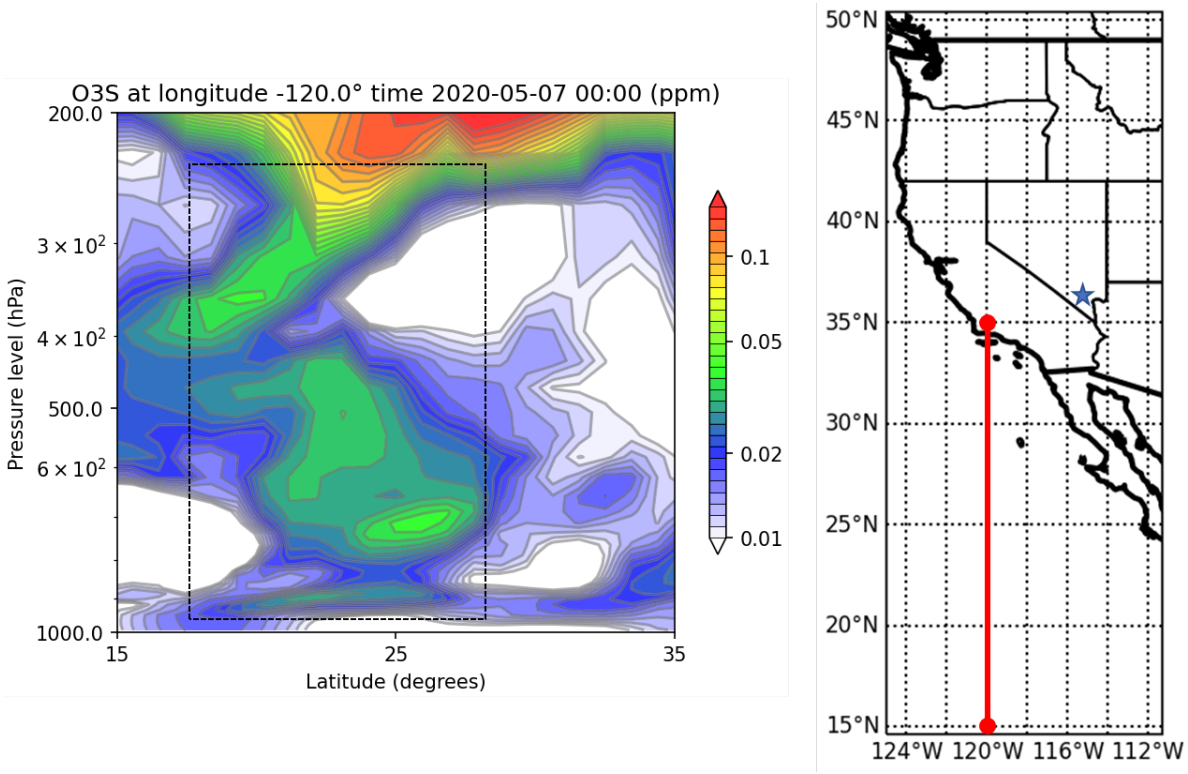

Figure A-10. WACCM-modeled cross-section of the stratospheric ozone tracer along the 120 degrees west longitude line on May 7 at 0:00 UTC. The "tongue" of elevated ozone extending from the stratosphere into the mid-to-lower troposphere is boxed in black. The map to the right shows the extent of the cross section. Las Vegas is marked with a blue star.

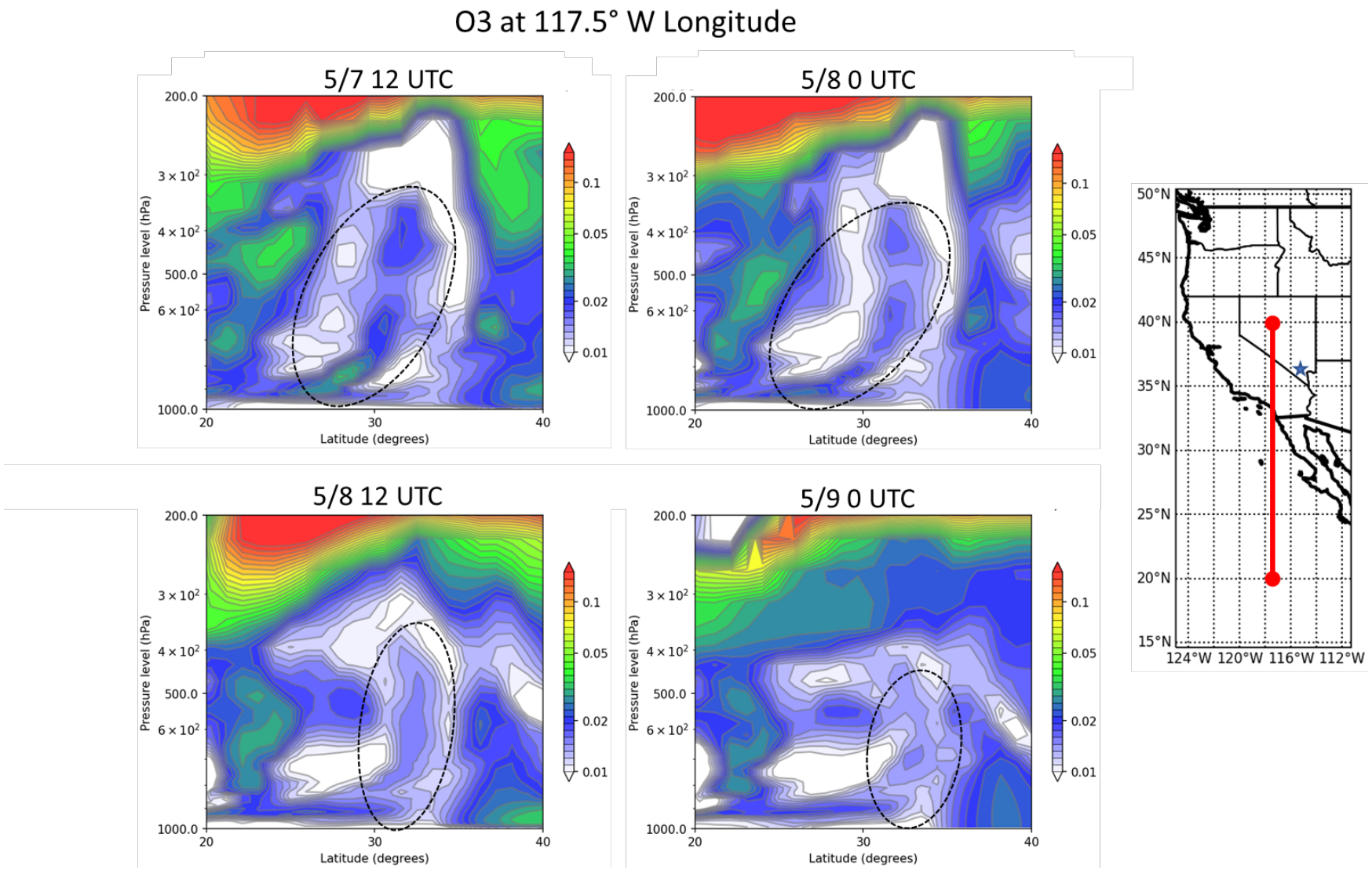

Figure A-11. Progression of WACCM-modeled cross-sections of the stratospheric ozone tracer along the 117.5-degrees west longitude line between May 7 at 12:00 UTC and May 9 at 0:00 UTC. The map to the right shows the extent of the cross section. Las Vegas is marked with a blue star.

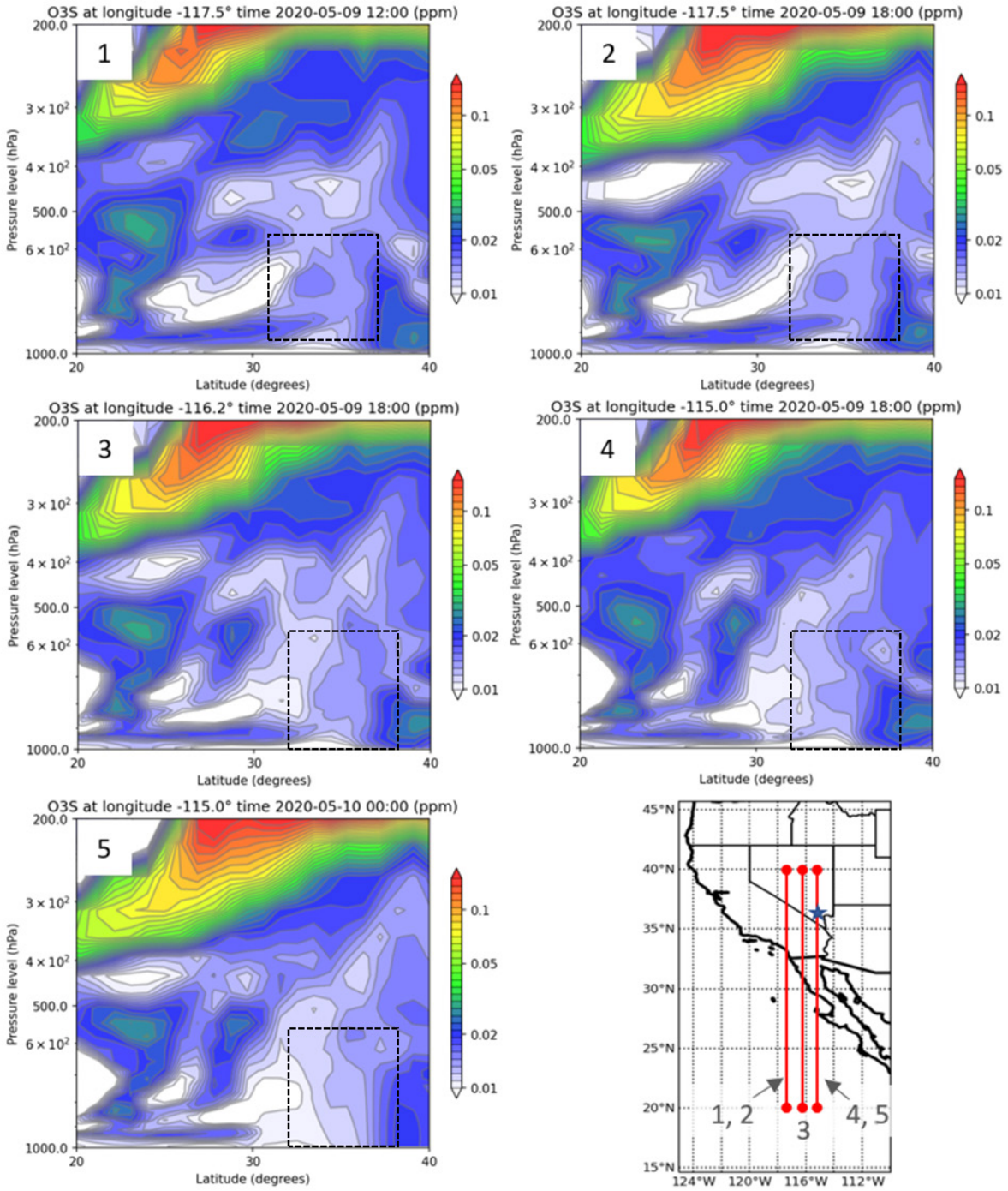

Figure A-12. WACCM-modeled cross-sections of the stratospheric ozone tracer on the event date, between 12:00 UTC (04:00 PST) on May 9 and 0:00 UTC on May 10 (16:00 PST on May 10). Cross sections along the 117.5-, 116.2- and 115.0-degrees west longitude lines are shown, and the number at the top left of each plot aligns with the labeled cross-section extents shown on the map. Vertical mixing in the mid-to-lower troposphere is indicated by the black boxes. Las Vegas is marked with a blue star on the map.

References

Chouza F., Leblanc T., Brewer M., Wang P., Piazzolla S., Pfister G., Kumar R., Drews C., Tilmes S., and Emmons L. (2020) The impact of Los Angeles basin pollution and stratospheric intrusions on the surrounding San Gabriel Mountains as seen by surface measurements, lidar, and numerical models. *Atmos. Chem. Phys. Discuss.*, 2020, 1-29. Available at https://acp.copernicus.org/preprints/acp-2020-1208/.

Appendix B. Figures and tables supporting Section 3.5.1, Matching Day Analysis.

Identification of matching (meteorologically similar) days includes a comparison of meteorology maps between May 9, 2020, and each date subset from candidate matching days. Surface and upper-level maps for May 9, and each date listed in Table 3-10 in Section 3.5.1 of the report show highly consistent conditions. At the surface, all dates show a low pressure system over Clark County, and most dates show a region of high pressure at the surface directly to the east of the surface low. Surface maps for May 9 and each date in Table 3-10 are shown in **Figure B-1 through Figure B-9**. Each upper-level map shows an upper-level ridge over Clark County. 500 mb maps for May 9 and each date in Table 3-10 are shown in **Figure B-10** through **Figure B-18**.

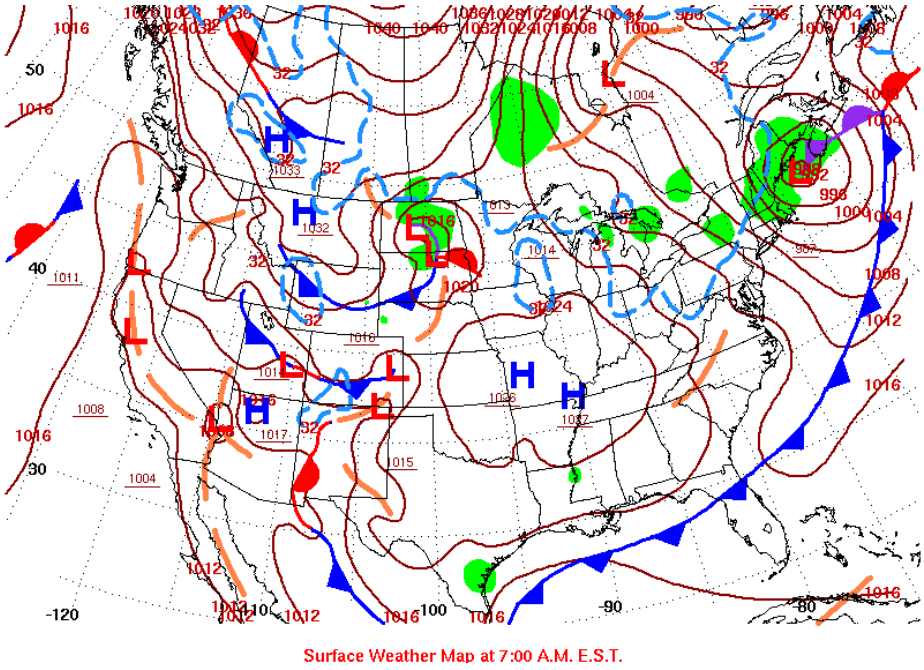

Figure B-1. Surface meteorology map on May 9, 2020 (the event date).

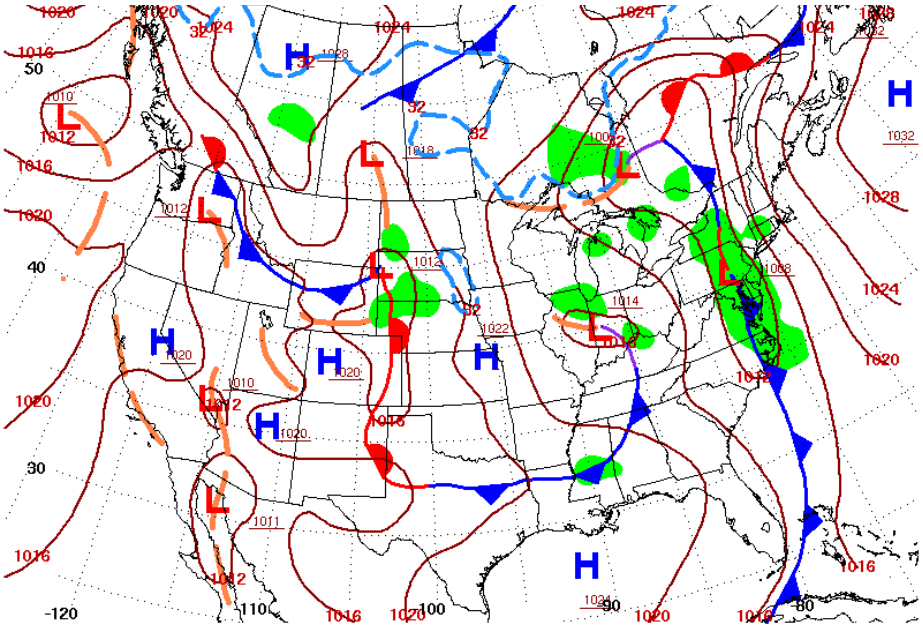

Figure B-2. Surface meteorology map on May 16, 2014.

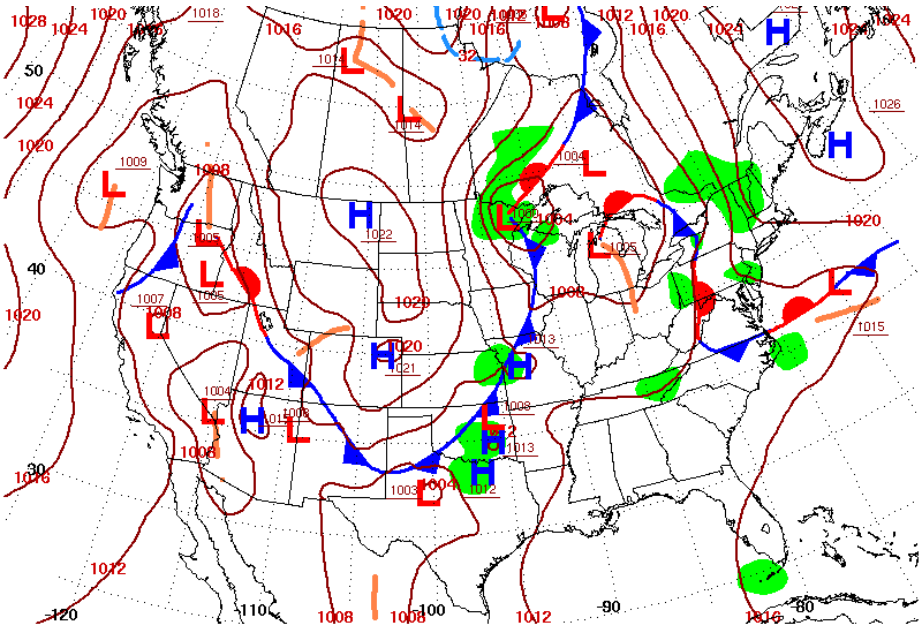

Figure B-3. Surface meteorology map on June 12, 2014.

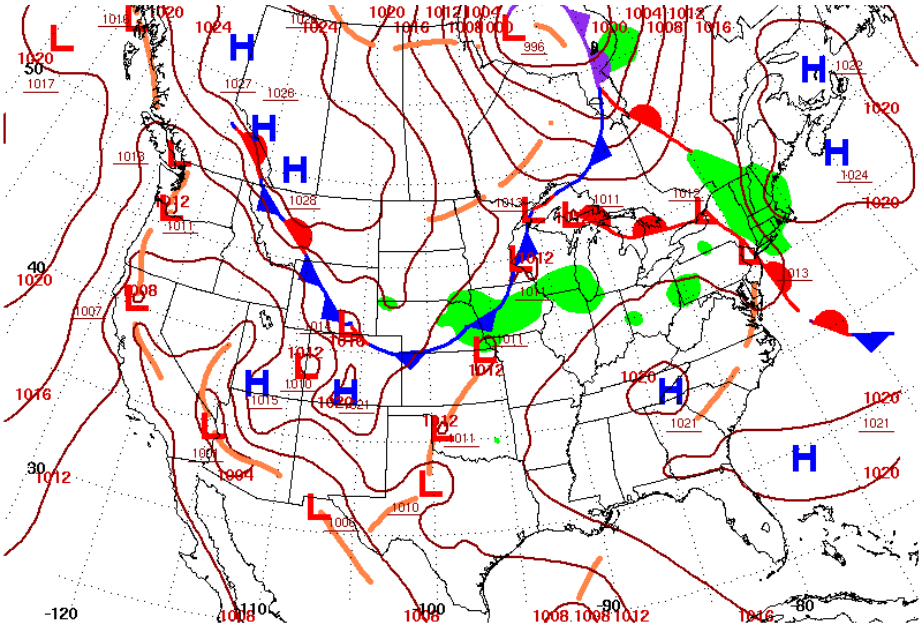

Figure B-4. Surface meteorology map on June 15, 2015.

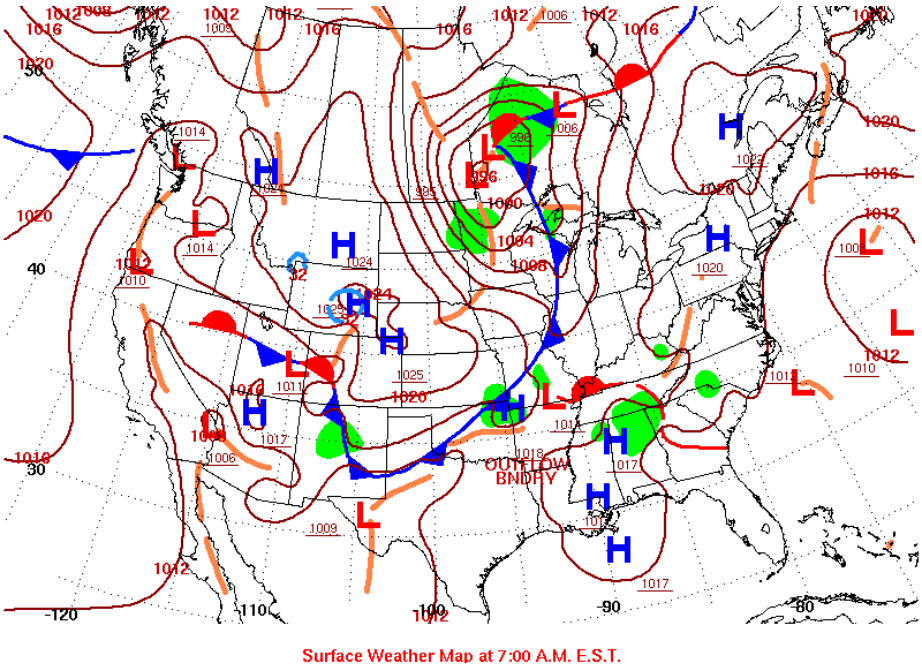

Figure B-5. Surface meteorology map on August 23, 2015.

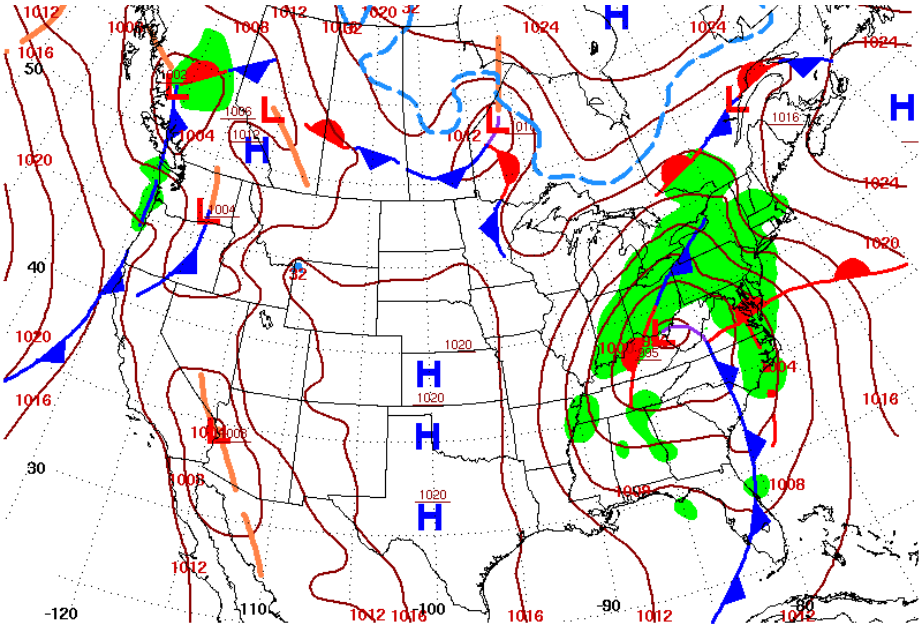

Figure B-6. Surface meteorology map on May 5, 2017.

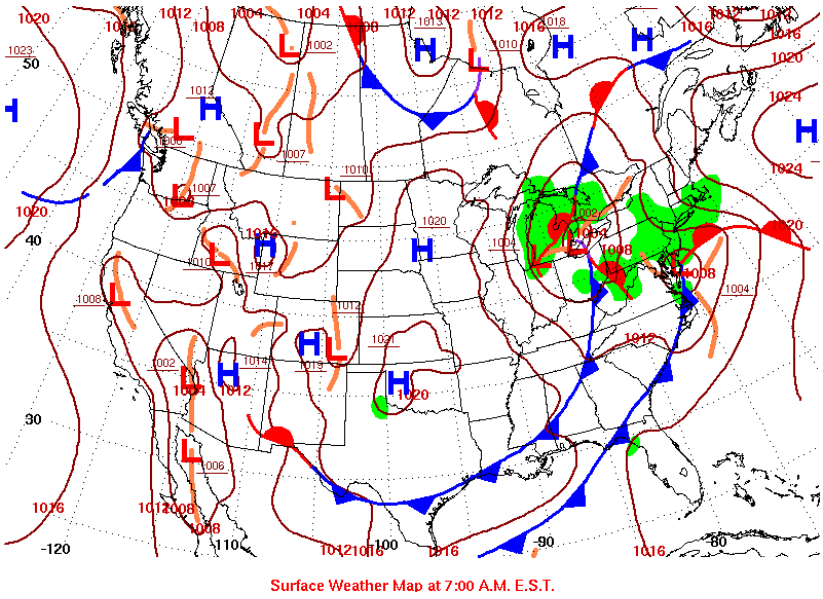

Figure B-7. Surface meteorology map on June 13, 2019.

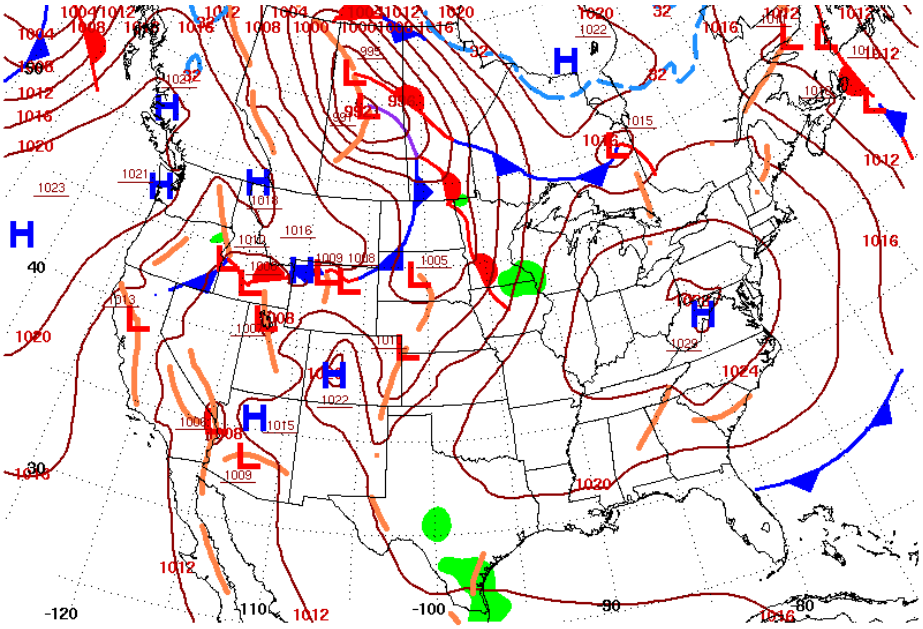

Figure B-8. Surface meteorology map on June 1, 2020.

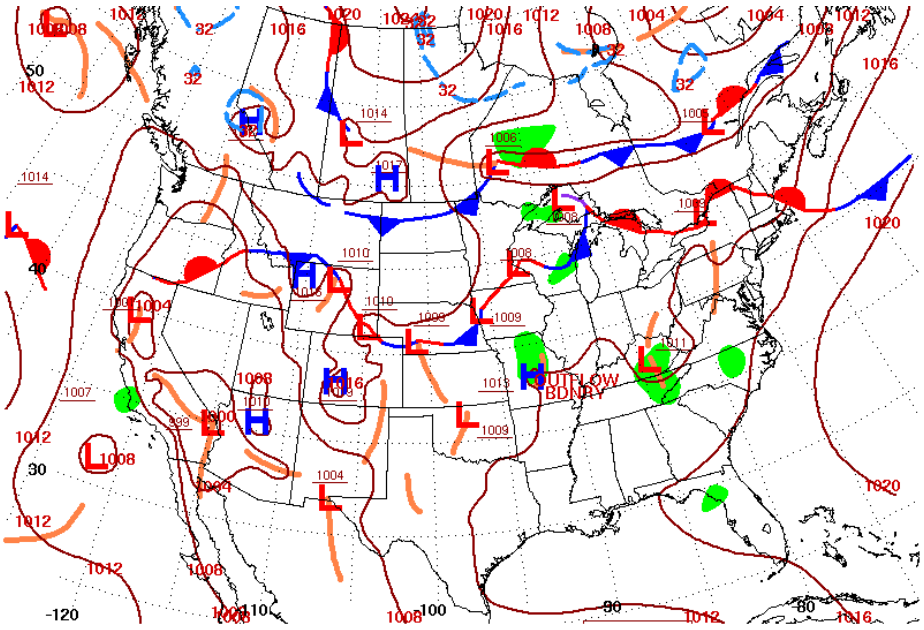

Figure B-9. Surface meteorology map on June 5, 2020

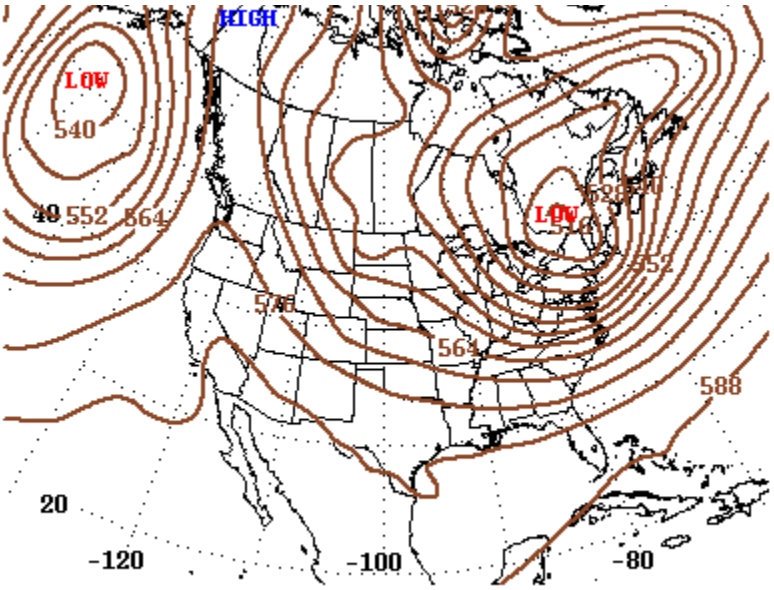

Figure B-10. 500 mb meteorology map on May 9, 2020 (the event date).

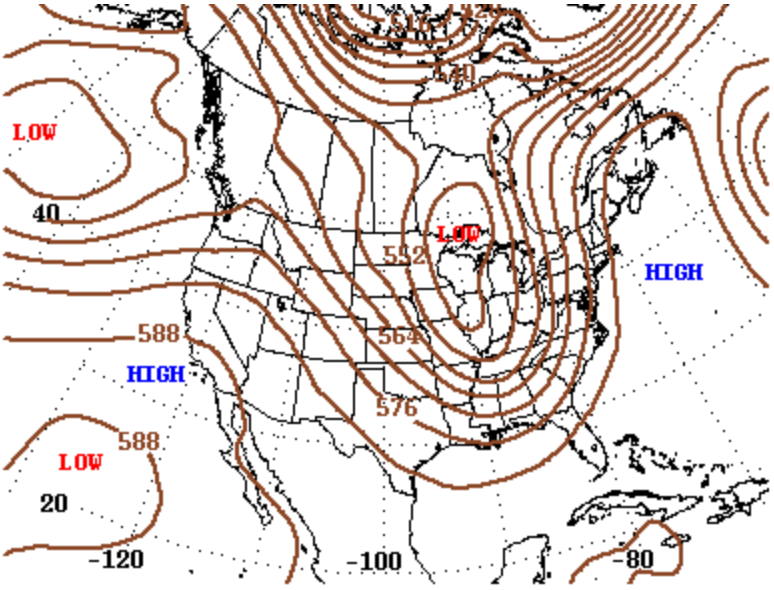

Figure B-11. 500 mb meteorology map on May 16, 2014.

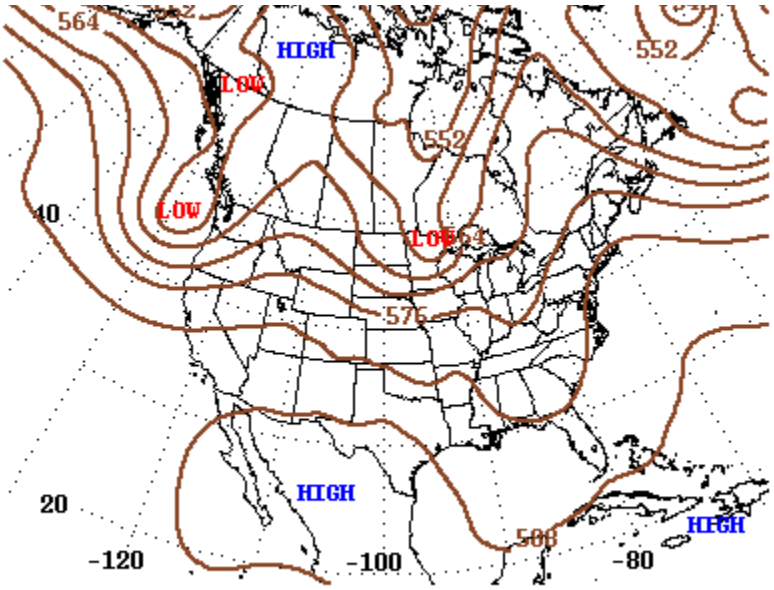

Figure B-12. 500 mb meteorology map on June 12, 2014.

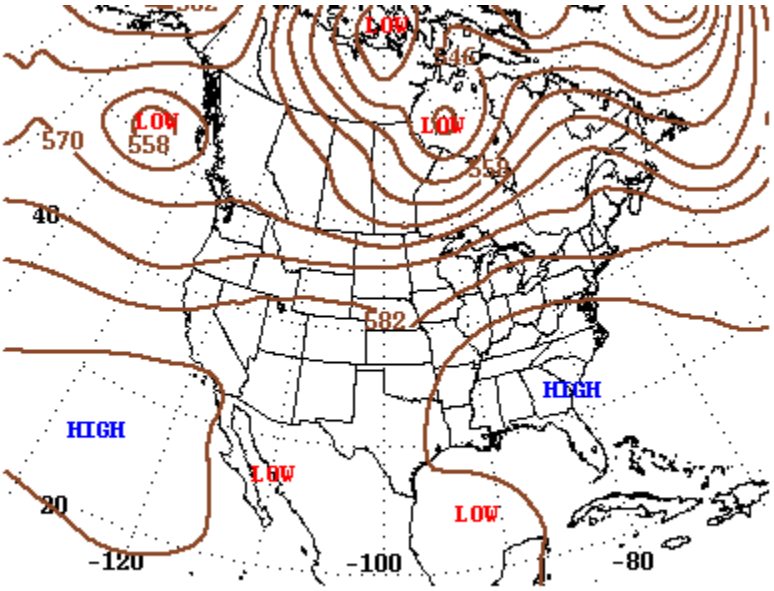

Figure B-13. 500 mb meteorology map on June 15, 2015.

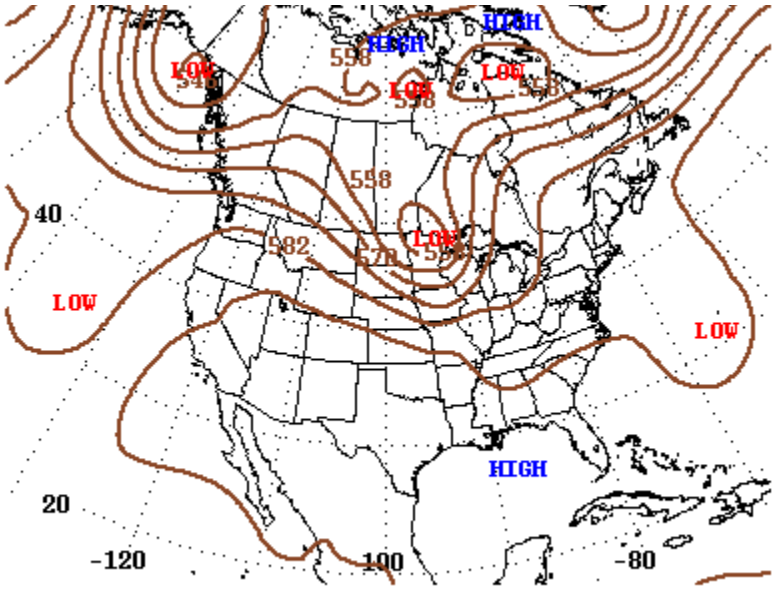

Figure B-14. 500 mb meteorology map on August 23, 2015.

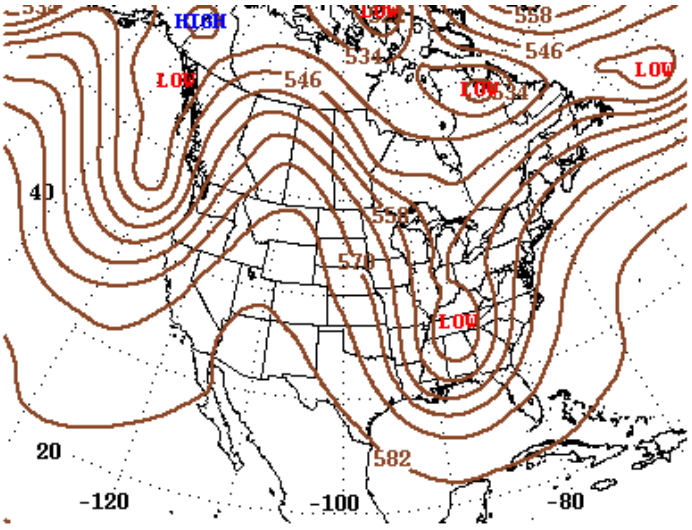

Figure B-15. 500 mb meteorology map on May 5, 2017.

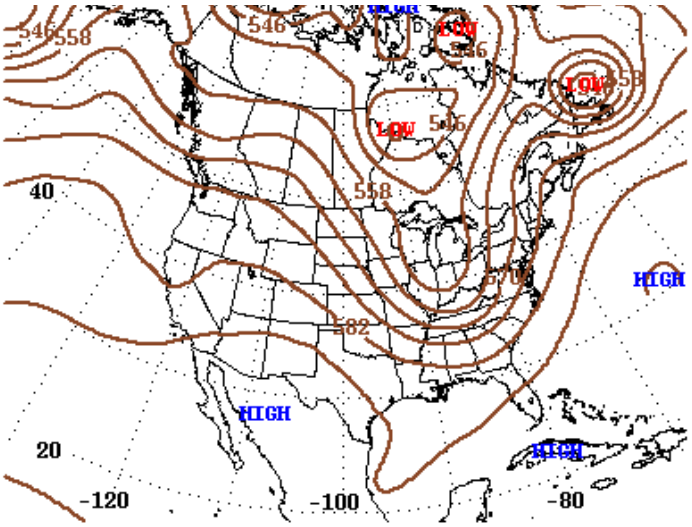

Figure B-16. 500 mb meteorology map on June 13, 2019.

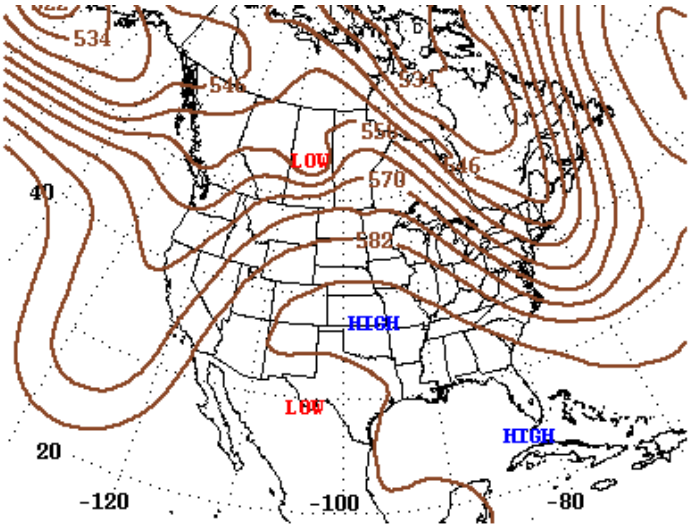

Figure B-17. 500 mb meteorology map on June 1, 2020.

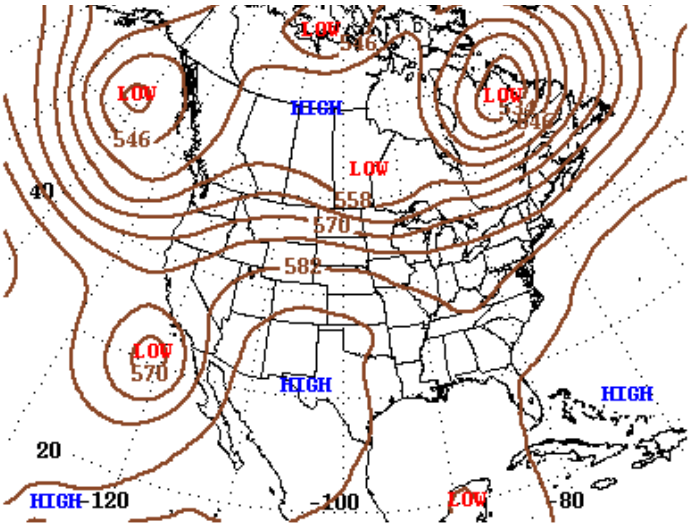

Figure B-18. 500 mb meteorology map on June 5, 2020.

Appendix C. GAM Residual Histograms and Scatter Plots from Concurred Exceptional Event Demonstrations

The following are GAM residual histograms and scatter plots from the concurred Arizona Department of Environmental Quality demonstration (Arizona Department of Environmental Quality 2016) and the submitted Texas Commission on Environmental Quality demonstration (Texas Commission on Environmental Quality 2021) for comparison with our GAM residual analysis. The figures in this Appendix show the good residual results from concurred and currently submitted exceptional events demonstrations to which we compared our results. Based on this comparison, we suggest that our GAM results show a well-fit, unbiased model. A well-fit GAM model should show a normal distribution of residuals at all sites modeled (ADEQ example in **Figure C-1**) and show no pattern or bias between GAM residuals and predicted values (TCEQ example in **Figure C-2**). These figures compare well with our GAM results in Section 3.5.2 of the main report.

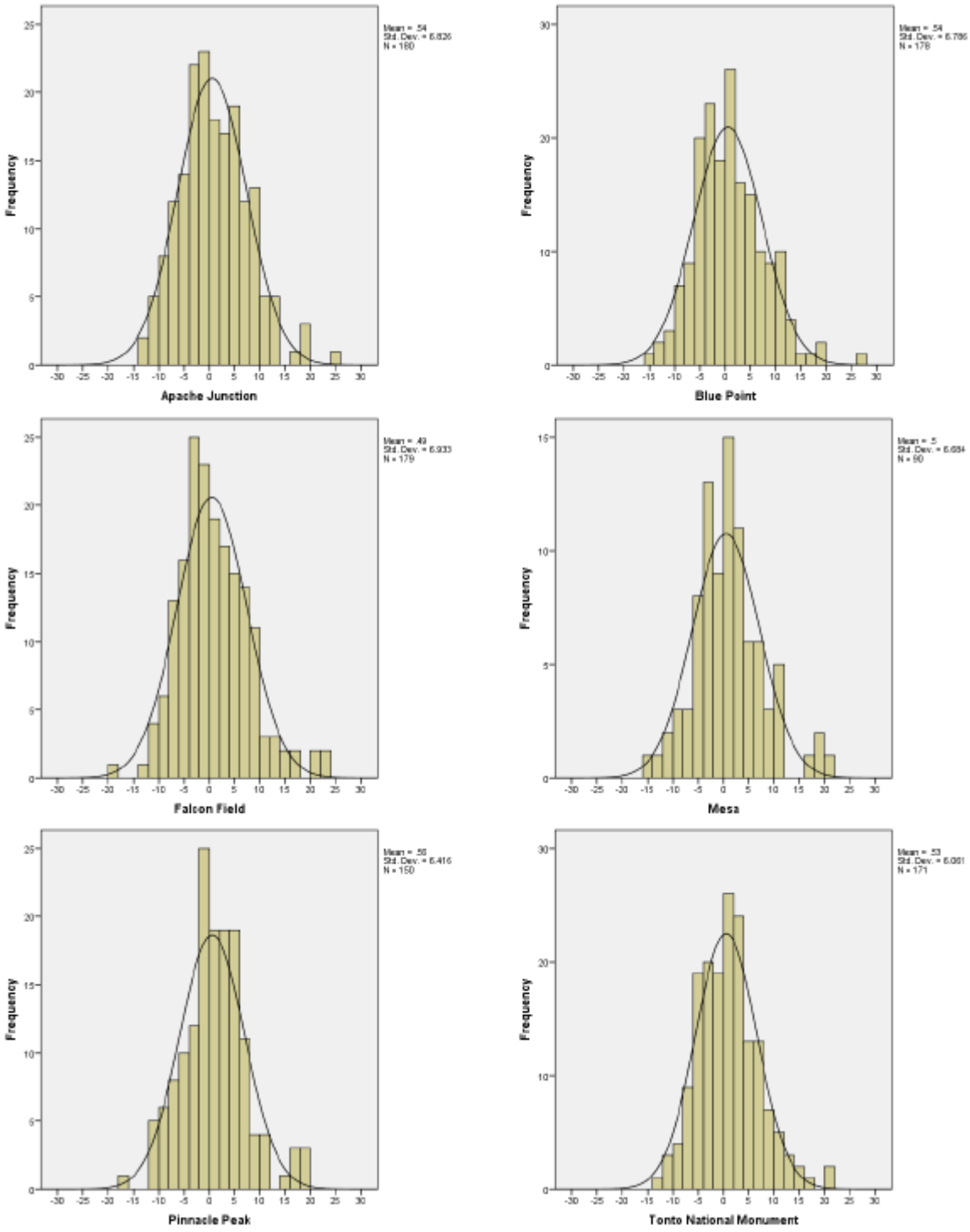

Figure C-1. Histograms of residuals results at each monitoring site from the Arizona DEQ GAM Analysis (Arizona Department of Environmental Quality 2016).

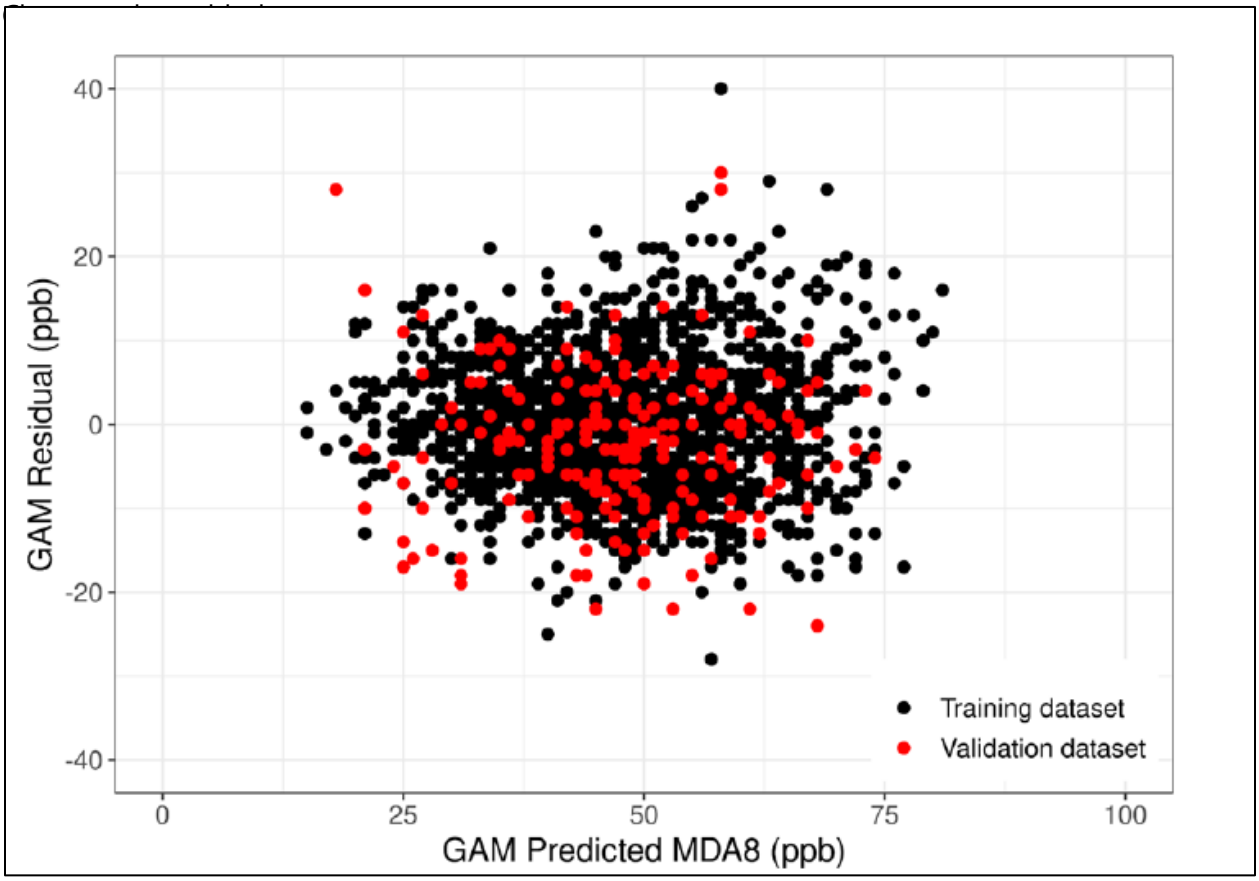

Figure C-2. Scatter plot of GAM residuals (observed – GAM predicted MDA8 ozone) vs. GAM predicted MDA8 ozone from the TCEQ submitted GAM analysis. Training data is shown in black and validation data is shown in red (Texas Commission on Environmental Quality 2021).

References

Arizona Department of Environmental Quality (2016) State of Arizona exceptional event documentation for wildfire-caused ozone exceedances on June 20, 2015 in the Maricopa nonattainment area. Final report, September. Available at https://static.azdeq.gov/pn/1609_ee_report.pdf.

Texas Commission on Environmental Quality (2021) Dallas-Fort Worth area exceptional event demonstration for ozone on August 16, 17, and 21, 2020. April. Available at https://www.tceq.texas.gov/assets/public/airquality/airmod/docs/ozoneExceptionalEvent/2020-DFW-EE-Ozone.pdf.

Appendix D. Documentation of Public Comment Process

To be updated once the public comment period has concluded.